Ocean-color remote sensing using non-polarized component of top-of-atmosphere reflectance

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Ocean-color remote sensing can be accomplished using non-polarized top-of-atmosphere (TOA) reflectance instead of total (i.e., polarized + non-polarized) reflectance, the usual way. The approach has several advantages: (1) the contribution of the water body to the TOA signal is generally enhanced, except over optically thick atmospheres (due to multiple scattering), (2) Sun glint is much less an issue (since light reflected by the wavy surface is strongly polarized), and (3) using polarization information in addition to spectral information in the near infrared and shortwave infrared in a classic, two-step atmospheric correction scheme facilitates determining the aerosol type (polarization rate depends on size distribution and index of refraction). An atmospheric correction scheme based on principal component analysis is applied to simulations of the TOA signal in the aggregated spectral bands of the PACE Ocean Color Instrument with typical radiometric noise. The simulations are performed for a wide range of expected conditions (geometric and geophysical), including Sun glint, absorbing aerosols, and Case 2 waters. In the scheme the principal components (PCs) of the total reflectance or the non-polarized reflectance that are sensitive to total water reflectance are identified and mapped to the PCs of the total water reflectance, allowing its reconstruction. Significant improvement in total water reflectance retrievals are obtained when working with TOA non-polarized reflectance, i.e., global RMS errors reduced by 28% at 350 nm, 36% at 443 nm, 25% at 550 nm, and 18% at 665 nm. This suggests that measuring polarization, even in a single direction, has great potential for ocean-color radiometry from space and should be considered to complement spectral measurements in the development of future ocean-color sensors.

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